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Document Name:	Specification	1
Document Name:	Drawing	1
Document Name:	Abstract	1

[Field of the Invention]

The present invention relates to an electromagnetic wave shielding material which shields undesirable electromagnetic wave radiated from outside of the environment and also shields electromagnetic wave leaking from inside of the environment.

[Background of the Invention]

In intelligent buildings and FA factories, electronic appliances and communication devices such as personal computers, office-automation devices, factory-automation devices etc. have been generally introduced. As a result, erroneous operations of electronic devices, as well as electronic wave disturbance such as communication disturbance, which occur inside these buildings and factories due to the electromagnetic wave radiated from the electronic appliances and the communication devices as described above or undesirable electromagnetic wave coming from the outside of the environment, have now become a significant social problem.

In order to prevent such leakage of undesirable electromagnetic wave from the environment, as well as erroneous operations of electronic devices and electronic wave disturbance such as communication disturbance due to invasion of extrinsic electromagnetic wave, it has been considered that an information network using optical fibers, coaxial cables or the like is established inside an

intelligent building or a FA factory so that information can be transmitted/received rapidly and accurately. However, there is a problem, in this method, that construction of such a network costs a lot of money. Therefore, there has been proposed another method in which the whole building is shielded from the outside environment and information exchange inside the building is carried out by wireless communication. In order to effect this method, it has conventionally been attempted that metal plates or metal foils of iron, copper, aluminum or the like as electromagnetic wave shielding materials are laminated to building materials such as board materials or a wall material which shields electromagnetic wave is employed.

Further, at opening/closing portions such as doors and windows, a gasket for shielding electromagnetic wave is generally provided, so that the undesirable electromagnetic wave radiated from outside of the environment, as well as the electromagnetic wave which leaks from inside of the environment, can be shielded.

Examples of such a gasket include a gasket produced by the steps of: slicing an elastic foam block such as polyurethane sponge by a predetermined thickness by a slicer; cutting each slice to pieces having a predetermined width, thereby to obtain short, strap-like structures each having a rectangular section; optionally connecting one structure with another at the ends thereof, thereby to obtain a long, strap-like structure; and laminating a

conductive sheet around each strap-like structure by way of an adhesive agent layer, the conductive sheet being composed of an aluminum foil laminate film or a conductive woven cloth, and a gasket for shielding electromagnetic wave which is produced by providing a metal film on the strap-like structure itself, the gasket being positioned into gaps or opening/closing portions of electronic devices, or window portions of doors in intelligent buildings or FA factories.

As another example, there is a gasket manufactured by a continuous foaming method wherein a conductive woven fabric such as nylon woven fabric coated with silver is inserted into a mold to produce a cavity and a foamable material is introduced into the cavity and foaming the material simultaneously to produce the gasket continuously.

Also, there is known a gasket produced by slicing an elastic foam block such as polyurethane sponge, providing conductivity thereto by means of a plating and cutting each slice to pieces having a predetermined width, thereby to obtain strap-like structures each having a rectangular section.

[Objects of the Invention]

However, in the aforementioned methods in which the elastic foam strap-like structure (such as a sponge) is employed, there arises a problem that slicing is difficult to perform when extremely thin slices (e.g., no thicker

than 2 mm) are to be obtained, because slices are produced by slicing the sponge-like, elastic foam block by a predetermined thickness by a slicer, as described above. In order to overcome this problem, there has been made an attempt that the elastic foam block is sliced thicker than the predetermined thickness and the obtained slices are made to have a predetermined thickness by compressing the slices under an increased pressure and providing the slices with permanent strain or the elastic foam block is sliced thinner than the predetermined thickness and the obtained slices are laminated.

Although these thicker block may be sliced, the accuracy of dimension in the thickness direction is poor. Thus, the accuracy of dimension of the gaskets obtained by adhering a conductive sheet onto the elastic foam strap-like structure herically or by electroless-plating are insufficient. If these gaskets are used for the above electromagnetic wave shielding purpose, it is difficult to obtain a desired electromagnetic wave shielding property and also their production cost is expensive due to many production steps.

The above mentioned continuous method can produce gaskets with high productivity, but setting of the processing conditions (including selection of the raw material for effecting foaming, the charging and foaming method, the temperature condition) is difficult and thus high-standard control technique is required, resulting in a high facility cost. Further, in the gasket of such a type, the dimension

accuracy may be relatively poor because foaming tends to proceed to some extent even after the foamed product is pulled out of the mold. If these gaskets are used for the above electromagnetic wave shielding purpose, it is difficult to obtaine a desired electromagnetic wave shielding property.

In recent years, as the electric appliances are becoming thinner, a gasket material having thickness of 100-1000 μm or so is now increasingly in demand. This trend has made the aforementioned problem even more obvious.

The thickness of a conductive woven cloth produced by providing a woven cloth with conductivity is generally 60-200 μm or so, and the thickness of a conductive unwoven cloth produced by providing a unwoven cloth with conductivity is generally 60-500 μm or so. Such a conductive woven/unwoven cloth, which is made of only the conductive material, may be used as a thin gaslekt material. However, as the conductive woven/unwoven cloth made of only the conductive material exhibits poor cushioning property, the conductive woven/unwoven cloth of such a type is not suitable as a gasket material.

Further, the conductive material produced by forming a metal layer on the surface of a porous skeleton such as a strap-shaped, urethane sponge-like elastic foam structure (the polyurethane porous structure, in particular) has defects such as poor deterioration resistance property, although the conductive material of such a type shows

relatively excellent electromagnetic wave shielding property.

[Means for Attaining the Objects]

In order to attain the objects, the present invention firstly resides in an electromagnetic wave shielding material comprises a fibrous structure base material and a conductive metal layer, wherein the fibrous structure base material is a three dimensionally knitted base material.

It secondary resides in the electromagnetic wave shielding material of the above first characterized in that the electromagnetic wave shielding material comprises a fibrous structure base material and a conductive metal layer, wherein the fibrous structure base material is a three dimensionally knitted base material composed of an upper ground structure, a lower ground structure and connection thread..

It thirdly resides in the electromagnetic wave shielding material of the above second, characterized in that the three dimensionally knitted base material has a double raschel structure.

It fourthly resides in the electromagnetic wave shielding material of any one of the above first to third, characterized in that a heat-fusing thread is used at least a portion of the three dimensionally knitted base material.

It fifthly resides in the electromagnetic wave shielding material of any one of the above first to fourth,

characterized in that a conductive metal layer of the electromagnetic wave shielding material is coated with a synthetic resin.

In the present invention, the type of the base material is not particularly restricted as long as the base material can have a three dimensional structure. However, it is preferable to employ a three dimensionally (woven-)knitted base material, which includes, as main constituent members, an upper ground structure, a lower ground structure and a connection thread for connecting the upper ground structure and the lower ground structure and is produced by knitting by a double row needle bed type weaving-knitting machine. Among the three dimensionally knitted base material, that having the double raschel knitting structure is particularly preferable. The base material having such a structure exhibits excellent recovering property from compression, as well as excellent deterioration resistance property, and thus can be preferably used as an electromagnetic wave shielding material for a gasket or the like.

Examples of the connection thread used in the three dimensionally knitted base material of the present invention include: the connection thread having a normally intersecting connection thread which connects the upper ground structure with the lower ground structure in a manner that the connection thread (substantially) normally intersects the upper ground structure and the lower ground

structure; the connection thread having a diagonally intersecting connection thread which connects the upper ground structure with the lower ground structure in a manner that the connection thread diagonally intersects the upper ground structure and the lower ground structure; the connection thread having a truss structure which includes both the normally intersecting connection thread and the diagonally intersecting connection thread in a combined manner. In terms of effectively achieving the resilient elasticity of the base material and reducing the compressive residual strain, the connection thread having the diagonally intersecting connection thread is preferable.

Monofilament yarns are preferably used as the connection thread in order to reduce blocks at the time of cutting the gasket.

Also, it is preferable that the upper and lower ground structures are made by poor stretching structures.

Examples of the fiber material which constitutes the fibrous structure knitted base material include the conventionally known base materials such as synthetic fiber and natural fiber. Among these examples, polyester fiber which has excellent resilience recovering property and deterioration resistance property, is preferable.

Further, it is preferable that a polyester-based heat-fusing thread is used. The type of the heat-fusing thread to be used is not particularly restricted.

Especially, it is preferable to use a polyester-based heat-

fusing thread of the core-sheath composite type in which a high-melting point polyester is used for the core portion and a low-melting point polyester is used for the sheath portion.

The heat-fusing thread may be used at any of the upper ground structure, the lower ground structure and the connection thread of the three dimensionally knitted base material. Use of the heat-fusing thread at the portions which constitute the upper ground structure and the lower ground structure is particularly preferable.

The fibrous structure base material can be entirely composed of heat-fusing threads and also heat-fusing thread(s) and regular thread(s) can be mixed or they can be used partially.

By heat-setting the three-dimensionally knitted base material comprising the heat fusing threads, the connecting portions of the upper ground structure, the lower ground structure and the connection thread are bonded thereby reducing debris or blocks appeared at the cutting and lowering the compression residual strain significantly.

The metal layer formed on the base material may be provided by using the known methods such as spattering, vacuum deposition and plating. In order to evenly form the metal layer and achieve excellent conductivity and shielding property, it is preferable that the metal layer is formed by electroless plating. Electrolytic plating may optionally be carried out after carrying out the

electroless plating.

Examples of the metal to be used for forming the metal layer include known metals such as silver, copper, and nickel.

In order to reduce the amount of cutting debris generated at the time of cutting and suppress separation of the metal layer from the base material, it is preferable that the metalized base material is coated with a resin, after the metal layer is provided on the base material, but prior to cutting. The type of the resin to be coated is not particularly restricted, and may be a thermoplastic resin or the like. In terms of achieving excellent workability and flexibility, an acrylic resin is preferable.

By adding various types of flame retardant, the fire retardancy of the product can be improved. Examples of the flame retardant include: the halogen-based flame retardant represented by bromine-based and chlorine-based flame retardant; the antimony-based flame retardant such as antimony trioxide; and the phosphorus-based flame retardant. These examples of the flame retardant may be used solely or in a combined manner. The combination of the bromine-based flame retardant and the antimony-based flame retardant, in particular, exhibits an excellent effect in use. Examples of the method of providing the flame retardant include padding, knife coating, and gravure coating of the mixture of the flame retardant and a solvent-based or water-based synthetic resin. As the fire retardancy of the product is

improved as a result of adding the flame retardant, the product can be used in the fields where excellent fire retardancy is required, such as electric appliances for domestic use.

As described above, the electromagnetic wave shielding material of the present invention employs the three dimensionally knitted base material such as the double raschel knitting structure. Accordingly, by setting the types of the thread to be used, the denier of the thread, the number of filament count, the knitting structure and/or the knitting density in an appropriate manner, the properties of the electromagnetic wave shielding material such as flexibility and residual stain after load-release can be controlled.

Further, the electromagnetic wave shielding material of the present invention can be used, not only for a gasket, but also for a taping material (a grounding material).

[Embodiments of the Invention]

Hereinafter the embodiments of the present invention will be explained.

[Examples]

The present invention will be specifically demonstrated by the following examples. The method of measurement used in the examples are as follows.

1. Thickness

Measurement was made according to JIS L-1098

The measuring device: At-constant-pressure thickness measuring device TYPE PF-11 (manufactured by Rafurokku Co.)

2. Pressure observed when the sample was compressed by 50 %

A sample which had been cut into 10 mm × 10 mm size was placed on a pressure receiving plate and compressed at the compression rate of 0.5 mm/sec. The load was recorded when the thickness of the sample shrank to 50 % of the original thickness. The measured load was divided by the area of the sample, whereby the pressure at the time of 50 % compression was obtained.

3. Shielding property

The shielding property was measured according to the KEC method, by using a sample of 120 mm × 120 mm size. Specifically, the sample was placed between the antenna for transmission and the antenna for reception in a shielded box, and the strength of the received electromagnetic wave was measured. The damping rate (dB) was obtained from the ratio of the strength value of the received electromagnetic wave with respect to the strength value of the received electromagnetic wave when the sample was not present.

4. Compression residual strain

Measurement is made according to JIS K-6400.

A sample piece is compressed to 50% of the initial thickness by using two compression plates.

The compressed sample piece was treated at 70°C for 22

hours. The sample piece is removed from the compression plates and allows to stand for 30 minutes under standard conditions and the residual strain after recovery is measured.

5. Metal separation

A sample of 50 mm × 50 mm size was placed on a white cloth. A roller of 500 g weight was placed on the sample. The roller was reciprocally operated on the sample 250 times, and then the condition of metal layer separation (peeling off) was visually evaluated.

○: Separation of metal was hardly observed.

△: Separation of metal was slightly observed.

×: Significant sepration of metal was observed.

6. Cutting debris

The generation of cutting debris at the time of cutting the sample with a pair of scissors was visually observed.

◎: Cutting debris was hardly generated.

○: Cutting debris was slightly generated.

△: Cutting debris was moderately generated.

×: Cutting debris was significantly generated.

Example 1

A double raschel three dimensionally knitted structure was produced by using a double raschel knitting device. Polyester fiber of 33 dtex/12f was used as the ground structures 1 and 2. Monofilament made of polyester fiber of 22 dtex was used as the connection thread. A blank

product of 24 course/inch and 22 well/inch was obtained.

Ground structure: L1(L6):86/02, L2(L5):02/20

Connection structure: L3:02/24/42/20

Next, the obtained blank product was scoured and dried, whereby excess oil contents and impurities were removed. Thereafter, the blank product was immersed, for two minutes, in an aqueous solution at the temperature of 40° C which contained 0.3 g/L of palladium chloride, 30 g/L of tin (I) chloride, and 300 ml/L of 36 % hydrochloric acid. The blank product was then washed with water. Thereafter, the blank product was immersed, for five minutes, in borofluoric acid whose acid concentration was 0.1 N at the temperature of 30° C. The blank product was then washed with water. Next, the blank product was immersed, for five minutes, in an electroless copper plating solution at the temperature of 30° C which contained 7.5 g/L of copper sulfate, 30 ml/L of 37 % formalin, and 85 g/L of Rochelle salt. The blank product was then washed with water. Thereafter, the blank product was immersed, for ten minutes and at the electric current density of $5A/dm^2$, in an electrolytic nickel plating solution of pH 3.7 at the temperature of 35° C which contained 300 g/L of nickel sulfamate, 30 g/L of boric acid, 15 g/L of nickel chloride, whereby nickel was plated on the product. The blank product was then washed with water. The obtained metal-coated, three dimensionally knitted structure was immersed in the acrylic resin emulsion ("Primal TR-934",

manufactured by NIPPON ACRYL KAGAKUSHA) for 30 seconds, so that excess resin was removed. The product was then dried, whereby an electromagnetic wave shielding material whose conductive metal layer was coated with the acrylic resin was obtained. The obtained electromagnetic wave shielding material exhibited little variation in thickness thereof, compression residual strain and shielding property which were as excellent as those of the gasket employing the conventional foam, and significantly reduced level of metal separation and cutting debris generation. The observed performances are summarized in Table 1.

Example 2

A double raschel three dimensionally knitted structure was produced by using a double raschel knitting device. Polyester fiber of 33 dtex/12f was used at the ground structures 1 and 2. Polyester-based heat-fusing monofilament thread of 22 dtex was used as the connection thread. A blank product of 43 course/inch and 24 well/inch was thus obtained.

Ground structure: L1(L6):88/00, L2(L5):02/20

Connection structure: L3:02/24/42/20

Then, the blank product was treated in the same manner as in Example 1 to obtain an electromagnetic wave shielding material coated with copper and nickel. The obtained gasket exhibited little variation in thickness thereof, compression residual strain and shielding property which

were as excellent as those of the gasket employing the conventional foam, and significantly reduced level of metal separation and cutting debris generation. The observed performances are summarized in Table 1.

Example 3

A double raschel three dimensionally knitted structure was produced by using a double raschel knitting device. Polyester fiber of 33 dtex/12f was used at the ground structures 1 and 2. Polyester-based heat-fusing composite thread (the core thereof made of regular polyester and the sheath thereof made of low-melting point polyester was used. Monofilament made of regular polyester fiber of 22 dtex was used as the connection thread. A blank product of 43 course/inch and 24 well/inch was thus obtained.

Ground structure: L1(L6):86/02, L2(L5):02/20

Connection structure: L3:02/24/42/20

Next, the obtained blank product was scoured and dried, whereby excess oil contents and impurities were removed. Then, the ground structure and the connection yarn were bonded by drying (heat-set) at 160° C. Thereafter, the blank product was immersed, for two minutes, in an aqueous solution at the temperature of 40° C which contained 0.3 g/L of palladium chloride, 30 g/L of tin (I) chloride, and 300 ml/L of 36 % hydrochloric acid. The blank product was then washed with water. Thereafter, the blank product was immersed, for five minutes, in borofluoric acid whose acid

concentration was 0.1 N at the temperature of 30°C. The blank product was then washed with water. Next, the blank product was immersed, for five minutes, in an electroless copper plating solution at the temperature of 30°C which contained 7.5 g/L of copper sulfate, 30 ml/L of 37 % formalin, and 85 g/L of Rochelle salt. The blank product was then washed with water. Thereafter, the blank product was immersed, for ten minutes and at the electric current density of $5A/dm^2$, in an electrolytic nickel plating solution of pH 3.7 at the temperature of 35°C which contained 300 g/L of nickel sulfamate, 30 g/L of boric acid, 15 g/L of nickel chloride, whereby nickel was plated on the product. The blank product was then washed with water. On the surface of foam cells a nickel, copper and nickel layers were formed in this order uniformly. The product was cut in the direction of width to obtain strap-like structures each having a rectangular section. The observed performances are summarized in Table 1.

Comparative Example 1

A plain fabric was prepared at a warp density of 160/inch and a welf density of 95/inch by using polyester fiber 56T/36f.

Next, the obtained fabric was scoured and dried, whereby excess oil contents and impurities were removed. Thereafter, the fabric was treated in the same manner as in Example 1 to obtain a conductive fabric coated with copper

and nickel.

The observed performances are summarized in Table 1.

Comparative Example 2

An elastic foam block made of polyether-based polyurethane having cell density of being 45 cell/inch was sliced by 2 mm by a slicer. After scoring and washing, the product was immersed, for two minutes, in an aqueous solution at the temperature of 40°C which contained 0.3 g/L of palladium chloride, 30 g/L of tin (I) chloride, and 300 ml/L of 36 % hydrochloric acid. The blank product was then washed with water. Thereafter, the blank product was immersed, for five minutes, in borofluoric acid whose acid concentration was 0.1 N at the temperature of 30°C. The product was then washed with water. Next, the product was immersed, for five minutes, in an electroless nickel plating solution at the temperature of 35°C which contained 15 g/L of nickel sulfate, 10 ml/L of 37 % sodium hypophosphite, and the pH was adjusted to 8.1 with ammonia and sodium hydroxide. The product was then washed with water. Thereafter, the nickel-deposited product was immersed, for five minutes, in an electroless copper plating solution at the temperature of 30°C which contained 7.5 g/L of copper sulfate, 30 ml/L of 36 % formalin, and 85 g/L of Rochelle salt. The blank product was then washed with water. Thereafter, the product was immersed, for ten minutes and at the electric current density of $5A/dm^2$, in

an electrolytic nickel plating solution of pH 3.7 at the temperature of 35° C which contained 300 g/L of nickel sulfamate, 30 g/L of boric acid, 15 g/L of nickel chloride, whereby nickel was plated on the product. The product was then washed with water. On the surface of foam cells a nickel, copper and nickel layers were formed in this order uniformly. The product was cut in the direction of width to obtain strap-like structures each having a rectangular section. The observed performances are summarized in Table 1.

Table 1

	Thickness (mm)	Scatter in Thickness (mm)	Compression Residual Strain (%)	Shielding property (dB 100MHz)	Metal Separation	Cutting debris
Ex.1	2.0	±0.02	15	81.4	◎	◎
Ex. 2	2.0	±0.02	14	82.8	○	○
Ex. 3	2.0	±0.02	9	84.8	○	◎
Com. Ex. 1	0.1	±0.01	5	76.2	○	△
Com. Ex. 2	2.0	±0.50	13	88.4	○	×
Com. Ex. 3	2.0	+0.30	33	103.4	△	×

[Effects of the invention]

The present invention provides an electromagnetic wave shielding material, which has an excellent dimensional accuracy, constant thickness, compression residual strain and shieldability even in the case of a thin gasket as compared with conventional foam gaskets and also the cutting debris and the metal separation are little generated.

[Brief Description of the Drawing]

Fig. 1 is a schematic sectional view of one example of a three dimensionally knitted base material of the present invention.

[Explanation of Numerals]

1. Upper ground structure
2. Lower ground structure
3. Connection thread

[Name of Document]

SPECIFICATION

[Title of the Invention]

ELECTROMAGNETIC WAVE SHIELDING MATERIAL

[Claims]

1. An electromagnetic wave shielding material comprises a fibrous structure base material and a conductive metal layer, wherein the fibrous structure base material is a three dimensionally knitted base material.

2. The electromagnetic wave shielding material of Claim 1, characterized in that the electromagnetic wave shielding material comprises a fibrous structure base material and a conductive metal layer, wherein the fibrous structure base material is a three dimensionally knitted base material composed of an upper ground structure, a lower ground structure and connection thread.

3. The electromagnetic wave shielding material of claim 2, characterized in that the three dimensionally knitted base material has a double raschel structure.

4. The electromagnetic wave shielding material of any one of claims 1 to 3, characterized in that a heat-fusing thread is used at least a portion of the three dimensionally knitted base material.

5. The electromagnetic wave shielding material of any one of claims 1 to 4, characterized in that a conductive metal layer of the electromagnetic wave shielding material is coated with a synthetic resin.

[Document] ABSTRACT

[Object]

To provide a gasket for shielding electromagnetic wave which has an excellent dimensional accuracy and a less compression residual strain even if the thickness is relatively small.

[Construction]

Fiber structure obtained by forming a conductive metal layer on a three dimensionally knitted base material.

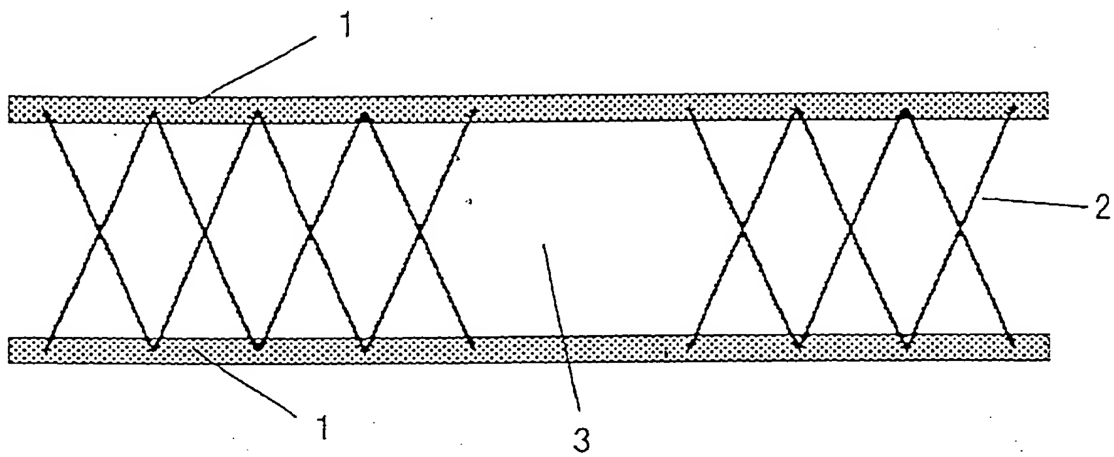

FIG. 1

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【提出物件の目録】

【物件名】　　　　明細書　１

【物件名】　　　　図面　１

【物件名】　　　　要約書　１

【プルーフの要否】　要

【書類名】　明細書
【発明の名称】　電磁波シールド材
【特許請求の範囲】
【請求項１】繊維構造基材と導電性金属層から成る電磁波シールド材であって、繊維構造基材が立体構造編基材であることを特徴とする電磁波シールド材。
【請求項２】繊維構造基材と導電性金属層から成る電磁波シールド材であって、繊維構造基材が上下の地組織と連結糸から成る立体構造経編基材であることを特徴とする請求項１記載の電磁波シールド材。
【請求項３】立体構造編基材が、ダブルラッシェル編構造である請求項２記載の電磁波シールド材。
【請求項４】立体構造編基材が熱融着糸を用いて成ることを特徴とする請求項１乃至３記載の電磁波シールド材。
【請求項５】導電性金属層を合成樹脂で被覆した請求項１乃至４記載の電磁波シールド材。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、外部からの不要輻射電磁波を遮蔽したり、内部より漏洩する電磁波を遮蔽する為に用いる電磁波シールド材に関する。
【０００２】
【従来の技術】
インテリジェントビルやＦＡ工場内においては、パーソナルコンピュータ、オフィスオートメーション機器、ファクトリーオートメーション機器などの電子応用機器や通信機器が導入され、これらから放射される電磁波、或いは、外来の不要電磁波による、建物内の電子機器の誤作動や、通信障害などの電波障害が大きな社会問題になっている。
【０００３】
これらの不要電磁波の漏洩防止、或いは外来の電磁波の侵入による電子機器の誤作動や、通信障害などの電波障害を防止するために、インテリジェントビルや

ＦＡ工場内に、光ファイバーや同軸ケーブルなどを用いた情報ネットワークを構築し、迅速で的確な情報のやりとりを行うことも考えられるが、ネットワーク構築に膨大な費用がかかるという問題が生じている。そこで、ビル全体を外界より遮蔽し、建物内部で無線通信により情報交換を行う方法が取り入れられている。そのため、従来より、電磁波遮蔽材として鉄、銅、アルミニウムなどの金属箔、または、金属板が知られ、ボード建材等にこれらを張り合わせて施工していたり、その他電磁波を遮蔽する壁材を用いたりしている。

【０００４】

また、扉などの開閉部や窓部には、外部からの不要輻射電磁波を遮蔽したり、内部より漏洩する電磁波を遮蔽する電磁波シールド用ガスケットが用いられている。

【０００５】

これらガスケットの例としては、電子機器筐体の隙間や開閉部、或いは、インテリジェントビルやＦＡ工場の扉部や窓部に、例えば、ポリウレタンスポンジ等の弾性発泡体ブロックをスライサーにより所定の厚みにスライスした後、巾方向に所定巾にカットして断面視で矩形の短尺紐状体となし、必要に応じその紐状体の端部同士を次々に接合して長尺紐状体にしてから、その周りに導電性織布やアルミニウム箔ラミネートフィルムからなる導電性シートを接着剤層を介して胴巻き状に貼着したものや、紐状体そのものに金属皮膜を形成した、電磁波シールド用ガスケットが用いられている。

【０００６】

また、他の方法によるものとしては、銀コートナイロン織布などの導電性織布を金型に挿入して空洞を作りつつ、その空洞に発泡性原料を充填しながら発泡させていくことにより連続的にガスケットを製造する、いわゆる、連続発泡法によるガスケットが知られている。

【０００７】

更には、ポリウレタンスポンジ等の弾性発泡体ブロックをスライサーにより所定の厚みにスライスした後、メッキ処理によって導電性が付与され、更に所定巾にカットして断面視で矩形の紐状体の電磁波シールド性ガスケットが知られてい

る。

【０００８】

【発明が解決しようとする課題】

しかし、上述の方法のように、スポンジ状の弾性発泡紐状体を用いるものは、スポンジ状の弾性発泡体ブロックをスライサーにより所定の厚みにスライスして作成するため、厚みが、たとえば２ｍｍ以下というように極端に薄いものを得ようとするときには、スライス自体が困難になるという問題がある。そこで、所定の厚みよりも厚くスライスして、所定の厚みにまで加圧圧縮することにより永久ひずみを与えて使用したり、所定の厚みよりも薄くスライスしたものを積層して使用することも行われてきた。しかし、このように、厚みがある程度厚いものはスライスが可能であるが、厚み方向の寸法精度が劣るため、弾性発泡紐状体に導電性シートを胴巻き状に貼着して得たガスケットや無電解メッキ等を施してなるガスケットの寸法精度も不十分となり、このガスケットを前記の電磁波シールドの目的に用いた場合、所期の電磁波シールド性が得られない虞もあり、また、製造工程が多いためコスト高になっていた。

【０００９】

また、前記の連続発泡法によるガスケットは、生産性が高いという利点はあるが、発泡の為の原料の選択、充填・発泡方法、温度条件など加工条件の設定が難しく、高度の制御技術が必要であり、装置コストも高くなるなどの問題点がある。更に、発泡後の製品を金型から引き出した後も若干発泡が進むため寸法精度が劣ることがあり、この方法で製造したガスケットを筐体の電磁波シールドの目的に用いた場合、所期の電磁波シールド性が得られないおそれがある。

【００１０】

また、近年、電気製品の薄型化が進み、要求されるガスケット材の厚さも、１００～１０００μｍ程度のものが増えてきており、前述の問題がクローズアップされてきている。

また、織布に導電性を付与してなる導電性織物の厚みは、６０～２００μｍ程度であり、また、不織布に導電性を付与してなる導電性不織布の厚みは６０～５００μｍ程度が一般的であり、これらは導電材料単体での薄手のガスケット材とし

ての使用が考えられる。しかし、クッション性に劣るため、このような導電材料単体ではガスケット材としては不向きであった。

【００１１】

更に、ウレタンスポンジ状の弾性発泡紐状体など、多孔体骨格表面に金属皮膜層が形成されて成る導電性材料は、電磁波シールド性に優れていても、特にポリウレタン多孔体などは劣化耐久性に劣るといった欠点があった。

【００１２】

【課題を解決するための手段】

上記の問題を解決するために、本発明は、第一に、繊維構造基材と導電性金属層から成る電磁波シールド材であって、繊維構造基材が立体構造編基材であることを特徴とする電磁波シールド材に存する。

【００１３】

また、第二に、繊維構造基材と導電性金属層から成る電磁波シールド材であって、繊維構造基材が上下の地組織と連結糸から成る立体構造経編基材であることを特徴とする上記第一に記載の電磁波シールド材に存する。

【００１４】

また、第三に、立体構造経編基材が、ダブルラッシェル編構造であることを特徴とする上記第二に記載の電磁波シールド材に存する。

【００１５】

また、第四に、立体構造編基材が熱融着糸を用いて成ることを特徴とする上記第１乃至３記載の電磁波シールド材に存する。

【００１６】

また、第五に、導電性金属層を合成樹脂で被覆した上記第１乃至４記載の電磁波シールド材に存する。

【００１７】

本発明においては、基材は立体構造をとるものであればどのような基材でも用いることができるが、上面地組織と下面地組織、並びにこれらを連結する連結糸とを主な構成部材とする、２列針床経編機によって編成される立体構造経編基材を用いることが好ましい。特に、立体構造経編基材の中でもダブルラッシェル編

み構造のものが好ましい。このような構造のものは、圧縮復元力、劣化耐久性に優れているので、ガスケットなどの電磁波シールド材として用いることができる。

【００１８】

連結糸は、上面地組織、下面地組織に対して、ほぼ直交状態で連結する直交連結糸を有するもの、上面地組織、下面地組織に斜交した状態で連結する斜交連結糸を有するもの、或いは直交、斜交の連結糸を同時に併せ持つトラス構造のもの等があるが、基材の反発弾性を発現させるためには、斜交連結糸を有するものが好ましい。

また、連結糸はガスケット切断時の屑発生を少なくするためにモノフィラメント糸を用いるのが好ましい。また、切断の際には連結糸の無い部分を切断するようにすればよい。

【００１９】

更に、上面地組織、及び、下面地組織は伸びにくい組織とするのが好ましい。

【００２０】

基材を構成する繊維材料は合成繊維、天然繊維など従来公知のものを使用することができるが、弾性回復性や、劣化耐久性に優れたポリエステル繊維を用いることが好ましい。

更に、ポリエステル系熱融着糸を用いると好ましい。用いる熱融着糸はどのようなタイプのものも用いることができるが、芯部にレギュラーポリエステル、鞘部に低融点ポリエステルを用いた芯鞘複合型の熱融着糸を用いることが好ましい。熱融着糸は立体構造経編基材の上面地組織、下面地組織、或いは連結糸の何れに用いても差し支えないが、上面地組織、及び下面地組織を構成する部分に用いるのが好ましい。

繊維構造基材を全て熱融着糸にて構成してもよく、レギュラー糸と熱融着糸を混繊して用いても良い。また、熱融着糸、或いはレギュラー糸と熱融着糸を混繊したものを部分的に用いても良く、特に限定されない。

熱融着糸を用いた立体構造経編基材を熱セットすることで、上面地組織、下面地組織、連結糸部の接合部が固着され、切断時の屑発生と、圧縮残留歪みの低減

をはかることができる。

【００２１】

基材に形成される金属層は、スパッタリング、真空蒸着メッキなど公知の方法を用いることができるが、金属層の均一化、連続性を考慮すると、無電解メッキにて形成されることが好ましい。更に、無電解メッキを行った後に電気メッキを行ってもよい。

金属層形成に用いられる金属は、銀、銅、ニッケルなど公知のものを用いることができる。

【００２２】

また、切断時の切り屑の発生、及び、金属層の基材からの剥離を低減するために、基材に金属層付与後、切断前に、樹脂によりガスケット基材を被覆することが望ましい。用いられる樹脂は熱可塑性樹脂など特に限定されるものではないが、加工性、柔軟性を考慮するとアクリル樹脂が好ましい。

【００２３】

また、各種難燃剤を付与することで、難燃性能を向上させることが出来る。難燃剤としては、臭素系，塩素系に代表されるハロゲン系難燃剤、三酸化アンチモン等のアンチモン系難燃剤，燐系難燃剤等を単独又は併用しても良い。特に、臭素系難燃剤とアンチモン系難燃剤を併用すると効果が高い。付与方法には、難燃剤を溶剤系又は水系の合成樹脂と混合し、パディング、ナイフコーティング，グラビアコーティング等を用いることが出来る。難燃性能を向上することで、家電製品等の特に難燃性能が要求される分野で使用することが出来る。

【００２４】

また、本発明による電磁波シールド材は、ダブルラッシェル編み構造などの立体構造編基材を用いているので、編み立て時に、使用する糸種や、糸繊度、フィラメントカウント数、編み組織、及び／又は、編み密度等を適宜設定することによって、電磁波シールド材の柔軟性や、荷重除去後の残留歪み等の性能を変えることができる。

また、本発明による電磁波シールド材はガスケットとしてはもちろんテープ材（グランディング材）として用いることができることはいうまでもない。

【００２５】

【発明の実施の形態】

以下、本発明の実施の形態について説明する。

【００２６】

【実施例】

次に実施例により本発明を例証する。実施例で用いた測定方法は次の通りである。

１．厚み

ＪＩＳ　Ｌ－１０９８に準じて測定した。

測定器…定圧厚さ測定器　ＴＹＰＥ　ＰＦ－１１（ラフロック社製）

２．５０％圧縮時圧力

１０ｍｍ四方の大きさにカットしたサンプルを受圧板にのせ０．５ｍｍ／ｓｅｃの速度にて圧縮し、試料の厚さが、初期の厚さの５０％になるときの荷重を読みとり試料の面積で除して、５０％圧縮時の圧力を得る。

３．シールド性

大きさ１２０ｍｍ×１２０ｍｍのサンプルを用いて，ＫＥＣ法によってシールド性を測定した。すなわちシールドボックスの中の送信用と受信用のアンテナの間にサンプルを設置し、受信した電解の強度を測定し、サンプルの非存在時の強度との比から減水率（ｄＢ）を求める。

４．圧縮残留歪

ＪＩＳ　Ｋ－６４００に準じて測定した。試験片を２枚の圧縮板を用いて初期厚さの５０％まで圧縮して固定する。圧縮された試験片を７０℃×２２時間処理する。サンプルを圧縮板から取り外して標準状態で３０分放置し回復させた後の残留歪を測定する。

５．金属剥離

白布の上に５０ｍｍ×５０ｍｍの大きさの試料を置き、試料の上に重量５００ｇのローラを置き、２５０回往復させた後の金属の脱落状況を目視にて判断する。

◎　金属の脱落がほどんど無い

○　金属脱落が少しある

△　金属の脱落がある

×　金属の脱落が激しい

６．切り屑

各試料をハサミで切断したときの切り屑の発生状況を目視にて判断する。

◎　切り屑の発生がほとんど無い

○　切り屑の発生が少しある

△　切り屑の発生がある

×　切り屑の発生が激しい

【００２７】

【実施例１】ダブルラッシェル機を用いて、立体編物を作成する。地組織１、２には、ポリエステル繊維３３Ｔ／１２ｆを使用する。又、連結糸にはポリエステル繊維２２Ｔのモノフィラメントを使用し、次に示す組織で編成し、４３コース／吋、２４ウエル／吋の生機を得る。

地組織　　　Ｌ１（Ｌ６）：８６／０２，Ｌ２（Ｌ５）：０２／２０

連結組織　　Ｌ３：０２／２４／４２／２０

次いで、得られた生機を、精練、乾燥して、余分な油分や不純物を除去する。引き続き、塩化パラジウム０．３ｇ／Ｌ、塩化第一錫３０ｇ／Ｌ、３６％塩酸３００ｍｌ／Ｌを含む４０℃の水溶液に２分間浸漬後、水洗した。続いて、酸濃度０．１Ｎのホウ沸化水素酸に３０℃で５分間浸漬後、水洗した。次に硫酸銅７．５ｇ／Ｌ、３７％ホルマリン３０ｍｌ／Ｌ、ロッシェル塩８５ｇ／Ｌから成る無電解銅メッキ液に３０℃で５分間浸漬後、水洗した。続いて、スルファミン酸ニッケル３００ｇ／Ｌ、ホウ酸３０ｇ／Ｌ、塩化ニッケル１５ｇ／Ｌ、ｐＨ３．７の電気ニッケルメッキ液に３５℃、１０分間、電流密度５Ａ／dm^2で浸漬しニッケルを積層させた後水洗した。更に、該金属被覆立体編物を、アクリル樹脂エマルジョン（日本アクリル化学社製　プライマルＴＲ－９３４）に３０秒浸漬後余分な樹脂を取り除いて乾燥して、導電性金属層をアクリル樹脂で被覆した電磁波シールド材を得た。厚さばらつきが少なく圧縮残留歪み、及び、シールド性が、従来の発泡体を用いたガスケット並の性能を有し、切断屑や金属剥離の少ない電

磁波シールド材を得た。性能を表１に示す。

【００２８】

【実施例２】ダブルラッシェル機を用いて、立体編物を作成する。地組織に１，２にはポリエステル繊維３３Ｔ／１２ｆを使用する。又、連結組織には、ポリエステル繊維２２Ｔのモノフィラメントを使用し次に示す組織で編成し、４３コース／吋、２４ウエル／吋の生機を得る。

地組織　　　Ｌ１（Ｌ６）：８８／００，Ｌ２（Ｌ５）：０２／２０

連結組織　　Ｌ３：０２／２４／４２／２０

以下、実施例１と同様に処理し、銅、ニッケルを積層させ、電磁波シールド材を得た。厚さばらつきが少なく圧縮残留歪み、及び、シールド性が、従来の発泡体を用いたガスケット並の性能を有し、切断屑や金属剥離の少ない電磁波シールド材を得た。性能を表１に示す。

【００２９】

【実施例３】ダブルラッシェル機を用いて、立体編物を作成する。地組織１，２にはポリエステル系熱融着糸３３Ｔ／１２ｆを用いる。熱融着糸は、芯部がレギュラーポリエステル（融点２５０℃）、鞘部が低融点ポリエステル（融点１６０℃）の芯鞘構造複合糸を用いる。また、連結糸にはレギュラーポリエステルの２２Ｔモノフィラメントを用い、次に示す組織で編成し、４３コース／吋、２４ウエル／吋の生機を得る。

地組織　　　Ｌ１（Ｌ６）：８６／０２，Ｌ２（Ｌ５）：０２／２０

連結組織　　Ｌ３：０２／２４／４２／２０

得られた生機を精練し、余分な油分や不純物を除去する。その後１６０℃で乾燥（熱セット）し、地部組織と連結糸の接合部を固着する。引き続き、塩化パラジウム０．３ｇ／Ｌ、塩化第一錫３０ｇ／Ｌ、３６％塩酸３００ｍｌ／Ｌを含む４０℃の水溶液に２分間浸漬後、水洗した。続いて、酸濃度０．１Ｎのホウ沸化水素酸に３０℃で５分間浸漬後、水洗した。次に硫酸銅７．５ｇ／Ｌ、３７％ホルマリン３０ｍｌ／Ｌ、ロッシェル塩８５ｇ／Ｌから成る無電解銅メッキ液に３０℃で５分間浸漬後、水洗した。続いて、スルファミン酸ニッケル３００ｇ／Ｌ、ホウ酸３０ｇ／Ｌ、塩化ニッケル１５ｇ／Ｌ、ｐＨ３．７の電気ニッケルメッキ

液に３５℃、１０分間、電流密度５Ａ／ｄｍ^{2}で浸漬しニッケルを積層させ水洗し、電磁波シールド材を得た。厚さばらつきが少なく圧縮残留歪み、及び、シールド性が、従来の発泡体を用いたガスケット並の性能を有し、切断屑や金属剥離の少ない電磁波シールド材を得た。性能を表１に示す。

【００３０】

【比較例１】ポリエステル繊維５６Ｔ／３６ｆを用い、経糸密度１６０本／吋。緯糸密度９５本／吋にて平織物を製織した。次いで、精練、乾燥して、余分な油分や不純物を除去する。引き続き、実施例１と同様に処理し、銅・ニッケルを積層させた導電性織物を得た。性能を表１に示す。

【００３１】

【比較例２】セル密度９５個／吋のポリエーテル系ポリウレタンからなる弾性発泡体ブロックをスライサーにより厚み２ｍｍにスライスした後、巾方向にカットして矩形断面の紐状体となし、比較例１の導電性織物をアクリル接着剤層を介して胴巻き状に貼着した電磁波シールド材を得た。性能を表１に示す。

【００３２】

【比較例３】セル密度４５個／吋のポリエーテル系ポリウレタンからなる弾性発泡体ブロックをスライサーにより厚み２ｍｍにスライスした後、精練洗浄し、塩化パラジウム０．３ｇ／Ｌ、塩化第一錫３０ｇ／Ｌ、３６％塩酸３００ｍｌ／Ｌを含む４０℃の水溶液に２分間浸漬後、水洗した。続いて、酸濃度０．１Ｎのホウ沸化水素酸に３０℃で５分間浸漬後、水洗した。次に硫酸ニッケル１５ｇ／Ｌ、次亜燐酸ソーダ１０ｇ／Ｌ、クエン酸ナトリウム１０ｇ／Ｌ、及び、アンモニア、苛性ソーダでｐＨ８．１に調整させた無電解ニッケルメッキ液に３５℃で５分間浸漬しニッケルを析出させ、その後水洗した。ニッケル析出後、硫酸銅７．５ｇ／Ｌ、３６％ホルマリン３０ｍｌ／Ｌ、ロッシェル塩８５ｇ／Ｌから成る無電解銅メッキ液に４０℃で５分間浸漬後、水洗した。続いて、スルファミン酸ニッケル３００ｇ／Ｌ、ホウ酸３０ｇ／Ｌ、塩化ニッケル１５ｇ／Ｌ、ｐＨ３．７の電気ニッケルメッキ液に３５℃、１０分間、電流密度５Ａ／ｄｍ^{2}で浸漬しニッケルを積層させ、水洗した。フォームのセル表面に下層よりニッケル、銅、ニッケルの順に均一な金属層が形成された。更に、巾方向にカットして矩形断面の

紐状体となし電磁波シールド材を得た。性能を表１に示す。

【００３３】

【表１】

	厚み (mm)	厚みばらつき (mm)	圧縮残留歪 (%)	シールド性 (dB 100MHz)	金属剥離	屑発生
実施例１	２．０	⊥０．０２	１５	８１．４	◎	◎
実施例２	２．０	±０．０２	１４	８２．８	○	○
実施例３	２．０	±０．０２	９	８４．８	○	◎
比較例１	０．１	±０．０１	５	７６．２	○	△
比較例２	２．０	±０．５０	１３	８８．４	○	×
比較例３	２．０	＋０．３０	３３	１０３．４	△	×

【００３４】

【発明の効果】本発明により、厚みが比較的薄いガスケットであっても寸法精度がよく、厚さばらつきが少なく圧縮残留歪み、及び、シールド性が、従来の発泡体を用いたガスケット並の性能を有し、切断屑や金属剥離の少ない電磁波シールド材を得た。

【図面の簡単な説明】

【図１】本発明に用いる立体構造編基材の略断面図の例である。

【符号の説明】

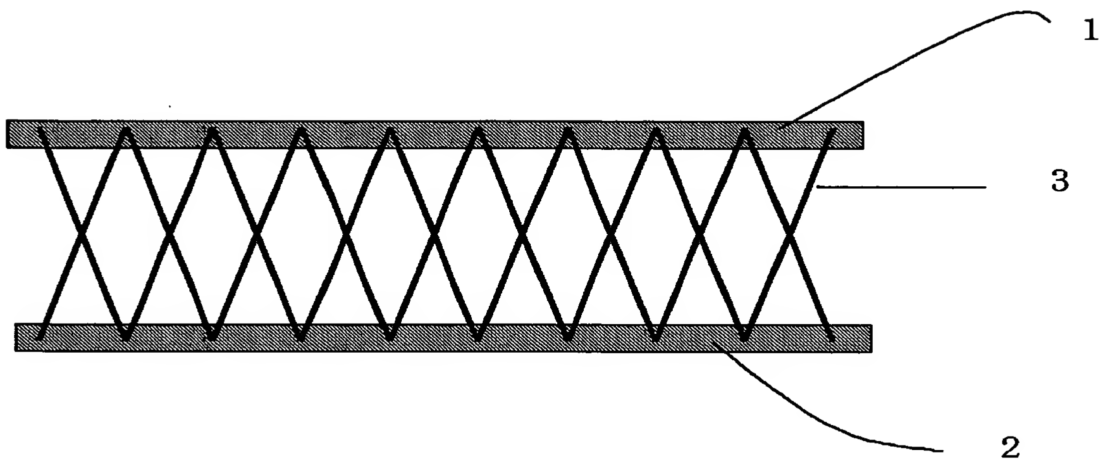
１…上面地組織

２…下面地組織

３…連結糸

【書類名】　図面

【図１】



【書類名】要約書

【要約】

【目的】電磁波を遮蔽する電磁波遮蔽シールド用ガスケットにおいて、厚みの比較的薄いものでも寸法精度が良く、圧縮残留歪の少ないガスケットを得る。

【構成】立体構造編基材に、導電性金属層が形成されて成る電磁波シールド用繊維素材。

出　願　人　履　歴　情　報

識別番号　　　　　〔０００１０７９０７〕

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